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**Cooperation between domestic universities and local companies: The case
of Russian chemical company “Pigment”.**

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Author's Declaration:

I hereby declare that I am the sole author of this Master Thesis and it has not been presented to any other university for examination.

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Abstract:

The goal of this paper is to determine types of knowledge transfers and obstacles to effective institutional cooperation between universities and the science-based industries in Russia. The research is based on the theoretical approaches of Schartinger (2002); Serrano-Bedia (2009), Salter (2009) to evaluate the cooperation from the position of the industry and science. The empirical studies include the analytical findings from surveys in the field of university-industry cooperation and proceedings of the interviews with representatives from the Russian chemical company “Pigment”.

This research explains the reasons obstacles to the cooperation are: difference in incentive systems, conflicts about evaluation of the intellectual property (IP), and availability of foreign knowledge from developed countries.

The key findings are the Russian chemical companies are not much interested in basic research from domestic Universities; they rely on the foreign experimental development and find it a more effective a way of cost-quality. Chemical industries develop internal R&D capabilities in order to refine foreign knowledge and implement it to current production. Domestic Universities are not interested much in revision of foreign R&D and have low absorptive capacity for it.

Key words: knowledge transfers, sectoral patterns, university-industry cooperation, differences in incentives, foreign substitutions.

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Introduction

Corporations that have strong networks with universities and the good internal capacity for application of scientific research usually have more advantages to solve the important problems which inhibit further progress (Rynes et al., 2001, 2). Therefore, firms in the industrial countries invest much in the R&D in order to create opportunities for new products and services (Bin Xu et al., 2005).

Co-operation is seen as a mean for improvement of the competitiveness and efficiency of the market actors: it increases the potential benefits for all stakeholders and opens the access to new knowledge and technologies. Scientific developments, which could be found in results of the university research, contribute to the innovation base of the economic sectors.

Each economic sector could rely more or less on the sources of the new knowledge (Klevorick et al, 1993). The science-based sectors heavily rely on university research (Ibid). It seems that linkages between universities and industries should be analyzed and measured on the level of the sectors' industrial activity – in a concrete sectoral pattern (Schartinger et al., 2002, 5).

The universities and industry are driven by different incentive systems; collaboration between both faces significant challenges. Universities are primarily driven to create new knowledge and educate, whereas private firms are focused on the capturing of valuable knowledge that can bring them commercial success and competitive advantages (Dasgupta et al., 1994).

In the developing economies, which Russia is belonging, incentives of domestic R&D institutions for creative innovation are not great enough (Braga et al, 1991), and government promotes a lot of research in military, aerospace and nano-industries, which is more beneficial for national development, but not for private business.

There are interesting findings: Russia has the third place after U.K. and Austria by the share of companies, engaging in collaboration on the innovations; 60 percent of the

Russian companies are intended to cooperate on the innovation activity, but the only 22 percent of them cooperate with the Universities and public R&D centers. This is a quite big gap, and it means that Russian companies prefer other institutions as partners for the R&D cooperation.

Conventional wisdom indicates that a lot of companies in developing economies prefer to import foreign technology (Braga et al, 1991), and the relationship between technological imports and technological efforts is necessarily one of the substitutions: increased import of technology implies a decrease in local R&D (Ibid, 1991).

The aim of this paper is to examine barriers in cooperation between chemical sector industries in Russia and the local R&D institutions. As an example of the chemical industry will be taken an organic pigment production company “Pigment JSC” (Pigment). This is one of the several medium enterprises in Russia, which has a big market share in Tambov region in central Russia.

I chose this company for empirical analysis, because it actively orders logistic services from their Estonian company “Eestichem OU”, where I am currently a sales manager. A logistics business’ success depends on the sales between production companies, such as Pigment, and their clients.

The hypothesis of this thesis is that Pigment does not tend to cooperate with local research institutions, because the company found foreign R&D more effective. Pigment prefers to directly communicate with foreign experts about implementation of purchased knowledge, because the local University is unable to do this.

In the empirical part, the hypothesis will be investigated through qualitative analysis of the interviews from an engineer and project manager from Pigment, and the researches from the chemical department in Tambov Technical State University (Tambov TU). Studies will cover some statistic data from surveys and previous scientific findings on obstacles for co-operation between universities and industries in Russia.

The empirical findings will be presented in a form of discussion about current theory limitations and will give proceedings for further studies on co-operation between science-based industries and academia in Russia.

1. Knowledge creation and diffusion among sectoral patterns

Knowledge is the central component in the innovation and production system and it is absorbed and accumulated by firms over the time (Nelson et al.,1993, 7-12).

For the industry, knowledge is connected with the scientific and technological opportunities in terms of development of innovations. The external environment affects firms through human capital and scientific knowledge, developed in the research centers and universities (Cimoli, 2006, 6-15).

Universities play three important roles within an innovation system. First, they undertake a general process of scientific research, and thereby affect the technological frontier of industry in a long-term. Secondly, they produce knowledge which is directly applicable to the industrial production. Thirdly, universities provide the significant outcomes for industrial innovation processes in terms of the human sources, either through the education of universities students, who become researchers in specific industries or through personnel mobility from universities to firms (Schartinger et al., 2002, 4). Universities contribute to the industrial innovation not only by offering different kinds of technological development, but also via a variety of created interactions (Serrano-Bedia et al., 8-10, 2009).

Scientific knowledge depends on the particular sectors. According to Freeman (1982), for some industries opportunity conditions are related to the scientific incubators in universities and for others, opportunities come from other appeared modernizations in the external R&D. Pavitt (1984) originally applied the idea of technological trajectories to the investigation of sectoral patterns of innovation. In his well-known taxonomy, he identified four major patterns of innovation (i.e. four dominant technological trajectories): supplier-dominated, scale-intensive, specialized suppliers, and science-based industries (Ibid, 1984).

But knowledge in the chemical sector is complex and cannot be reduced to a simple view. A more in-depth view on the sector would create a more complex image with the coexistence of at least three divisions: traditional scale-intensive industries (mainly

commodities and pseudo-commodities); firms, which act as specialized suppliers tailoring products with traditional technological content to the needs of their clients; and science-based firms in advanced technological areas and market (Cimoli, 2006, 6-15).

Although firms increasingly become multi-technological, not research conducted by universities is equally valid to the sectors of industrial activity (Pavitt, 1984). Obviously, that penetration of the research into real processes will be not the same in the intensity of knowledge transfers from university to industry (Ibid, 1997).

For a long time, technology and science was linked to the chemical sector. Chemical engineering is one of the results of this close link. Nowadays, the chemical sciences and engineering are in a process of great changes, which address future challenges: such as new synthesis techniques for combining molecules; catalyzers and reactive systems that allow to shorter life-cycle of products; more efficient and environmentally friendly processes and alternative uses of traditional raw materials (Cimoli, 2006, 6-15).

According to Nelson and Winter (1982) the nature of the scientific knowledge influence on the exchanges and transfers between innovating agents. Based on this, the authors differentiate between a so called more 'entrepreneurial' regime and a more 'routinized' regime in order to understand the variety of the innovation processes observed across industrial sectors. An 'entrepreneurial' regime is characterized by science-based technology. According to Nelson et al (1982), knowledge base there is non-cumulative and universal. On another hand, a 'routinized' regime is characterized by more cumulative experimental knowledge base. It is more specific to industrial applications (Nelson et al., 1982). These significant differences in the nature of knowledge, depicted in both regimes, may also carry some important implications for the knowledge transfer practices between academia and business (Breschi et al., 2000).

According to Gilsing et al (2011), organic pigment chemistry could be related with science-based regime, because this industry strongly depends on the external sources of knowledge such as research-intensive enterprises, universities and other public research institutes (Ibid, 3-5). Knowledge inputs in science-based industries, where organic pigment

chemistry is situated, are “often formed by publicly available scientific knowledge, which is then transformed through the use of formal scientific principles and methods into newly created knowledge” (Ibid, 3-5). Bulk of this newly created knowledge is presented in written papers and documents and is become available through different scientific publications, research conferences’ proceedings, reports and patent description.

2. The importance of the institutional cooperation

Co-operation is the most important knowledge-sharing factor that determines innovation. Comparative data on the prevalence of the collaboration in the innovation sphere shows that firms conducting R&D gain more value compared to those who are not involved in any research activity (OECD, 2013). Co-operation could be presented in several types. Three types of it are identified by the types of involved agents (Belderbos et al., 2004): horizontal (with competitors), vertical (with customers and suppliers) and institutional (with universities and/or research institutions).

In this research, the focus will be placed on the institutional cooperation, which is valuable for the sectoral system development (Schartinger et al., 2002, 1-3). The innovation system approach emphasizes the importance of links and connections among firms, public research institutions, and science and technology policy for success of innovations (Ibid, 1-3). Actors do not innovate as isolated units – there is a collective process between them: knowledge, technology, networks and institutions, altogether with the educational system and agencies that act in a heterogeneous and dynamic environment (Malerba et al., 2009, 8-17). The influence of actors and institutions is required for the innovative performance in order to reach a certain level of technical development in the sector.

2.1. Theoretical approaches on the institutional cooperation

Theoretical literature (Serrano-Bedia et al., 2009, 4-6) explains the decision of companies to establish partnerships with R&D institutions by three approaches: the resource-based view, transaction cost theory, and industrial organization theory (Ibid, 4-6).

Resourced-based theory (Wernerfelt, 1984; Barney, 1986) suggests that a firm's competitiveness is based on the internal resources, and that competitive advantages could arise from receiving such sources via cooperation with R&D departments (Arranz et al., 2008). But the main purpose of the resource-based view theory assumes cooperation as a mechanism to increase profit through resources of the partner (Kogut, 1988).

Transaction-cost theory views present cooperation as a combination form of organization between internal transactions of a firm and external transactions in the global market (Pisano, 1990). This theory proposes that a firms' decision on cooperation is based on the criterion of minimizing production and transaction cost (Williamson, 1985).

A concern of the Institution-Organization theory is that cooperative agreements rely on factors, which could affect social welfare, technology structure, and economic efficiency of a firm.(Serrano-Bedia et al, 2009, 7-14). This theory is mostly focused on the impact of internal R&D capabilities.

Two major determining factors, which undertaken in resource-based and industrial organization theory, on the decision of companies to set up institutional cooperation with R&D institutions are costs and risks of received innovations (Kale et al., 2000). Firms try to maximize incoming spillovers through cooperation, and to minimize outgoing spillovers, which put firms into the dilemma of “knowledge sharing” studied in the resource-based literature (Ibid), through investments in protection measures.

2.2. Knowledge transfers between Universities and industry

Working with universities on the research projects requires not only firm learns to work across organizational boundaries – it should be able to build the capabilities to collaborate with partners, who operate within a different incentive system (Salter et al., 2009, 10). Thus, collaboration with the universities requires firms to develop operating routines and practices to manage this partnership (Ibid, 10).

Innovative firms, who are involved in cooperation with universities, could be divided into several types (Ibid, 12). In recent studies they are classified as frequent and intermittent partners with universities (Hertzfeld et al., 2006; Bishop et al., 2008). Both types are particularly likely to earn on their collaboration experience by shifting information and knowledge gained through participation in multiple and diverse partnerships. Recurrent or intermittent collaborators are more likely to hold the necessary routines to reassure conflicting views on research targets (Gomes et al., 2005). They try to

speed up timing of the research results among other potential sources, and it could decrease the barriers related to research orientation (Salter et al., 2009, 11).

For both types of partners, cooperation mechanisms are dependent on the characteristics of the transferring knowledge, such as the level of codification, the openness or hiddenness in technological artifacts (Schartinger et al., 2002, 2). Thus cooperation is based on the degree of formalization, the suitability for transferring tacit knowledge and the level of personal trust and contacts (Ibid, 4).

Knowledge flows from universities to the industry appear to be strongest in the case of interactions, because they are based on the close and recurring personal contacts. This seems to be very important for joint research projects, publications; mobility of academic researchers and more beneficial formations for new firms (Schartinger et al., 2002, 4). Personal interactions are a precondition for transferring tacit, not-codified knowledge, which is regarded as particularly important for effective knowledge transfers in innovation processes. These interactions allow both partners to build up trust between each other, which is a crucial condition in cooperation, characterized by high uncertainty of results, involvement of highly sensitive knowledge, highly relevant for competition.

Different types of knowledge interactions are associated with different types of personal relations: joint publications and research projects are patterns of collaboration where one of several university researchers and at least one industrial specialist cooperate. “In joint supervisions of Ph.D. and Masters Theses the personal contact is maintained by a third party - the graduate or post-graduate student” (Schartinger et al., 2002, 4). Spin-off formations of new enterprises acquired researchers equipped with knowledge and trying to commercialized this knowledge in setting up own enterprise (Ibid, 4).

3. Nature of obstacles for collaboration between the domestic universities and industry.

Despite the recognized importance of the cooperation between universities and businesses, current academia-business environment in Europe is “underdeveloped and highly fragmented” (Kozlinska, 2011, 5). 40 percent of the academics are not involved in cooperation at all; and 20 percent - are engaged in cooperation to a very low extent (Ibid, 5).

Research in the science-based sectors, by its nature, involves considerable interaction with industrial practice (Rosenberg et al, 1994) and is true for the case study as organic pigment chemistry is a science-based sector. For the researchers dealing with science-based industries, practical problems give powerful incentives for development of new ideas, and they are more likely to investigate the real world problems and communicate with industry (Rosenberg, 2002). Thus, the status is highly determined by their standing in industry and reputation among peers (Ibid).

A considerable amount of evidence suggests that executives normally are afraid to turn to researchers, or scientific findings, in developing management strategies and practical projects [Rynes et al., 2-5, 2001 on Abrahamson, 1996; Mowday, 1997; Porter & McKibbon, 1988]. At the same time, researchers rather do not turn to practitioners for inspiration in establishing their research questions [Rynes et al., 2-5, 2001 on Sackett & Larson, 1990] or for insights for interpreting their results [Rynes et al., 2-5, 2001 on McNatt, & Bretz, 1999]. It is not a hard to understand that there is a considerably big gap that often exists between the normative recommendations from researchers and actual management practices in organizations (Rynes et al., 2001, 2-5).

3.1. Differences in incentives and orientation

Shrivastava and Mitroff (1984) suggested that academics and practitioners have completely different references and perception of information, the ways in which this information is arranged and organized for "sense-making", and the previous experiences

used to classify the validity of knowledge claims. Rynes et al.(2001) suggested that there are visible differences between researchers and practitioners with respect to the goals they seek to impact the social systems [Rynes et al., 2001 on Johns, 1993; Powell & Owen-Smith, 1998; Thomas & Tymon, 1982].

At the core of the obstacles between university-industry partnerships are the different institutional standards governing private and public knowledge (Dasgupta et al, 1994). The creation of authentic public knowledge has been central to the growth of the universities, leading to receive the support from government for research and expand the pool of economically valuable findings (Geuna et al., 2003). “Institutional norms are fundamental to the way that many academics perceive and perform their work. Scientists are willing to accept lower wages in order to work within the research institutions, and they become motivated by their intrinsic goals as well as the social objectives of the universities” (Geuna et al., 2003, 21-26). The priority of adjusting reputation through publication is necessarily for academic success and sustainable career in university. Academics often have to be involved in ‘status competitions’ with their colleagues, based on amount of publication, prizes and institutional affiliations (Salter et al., 2009, 5). Given this environment, much of the science system is driven by internal incentives that are divided from market transactions [Siegel et al., 2003 on Polanyi, 1962; Dasgupta et al, 1994; Stephan, 1996].

Some academics have argued that practitioners can be excellent scientific sources with their unique insights. Combined with academic sources, practitioners can stimulate important new scientific discoveries (Rynes et al., 2001, 8-15). But Powell and Owen-Smith (1998) argued that practitioners are most likely to seek alliances, when they face the most difficult and important scientific problems, which are hard to solve without scientist’ help (Rynes et al., 2001,8-15). University researchers are also prefer to choose research topics that are perceived by their professors to be valuable and interesting, while firms are likely to choose subjects and problems that are perceived as being useful for the development of new products and services for their customers (Nelson, 1993).

According to Siegel, industry managers found it hard to understand university-scientific norms. Business managers asserted that university scientists and administrators do not understand or appreciate industry goals and constraints, while university scientists and administrators believe that industry does not understand or appreciate university goals and culture (Siegel et al., 2003,10).

3.2. Conflicts over Intellectual Property and the University administration procedures

The rise of the university Technology Transfer Office (TTO) and the increasing attempts of universities to capture formal intellectual property have had a profound impact on the nature of scientific efforts (Salter et al., 10-17, 2009). These efforts have led to an expansion in the university patenting and the creation of a new commercial focus: the universities create valuable IP and exploit it for financial gain [Salter et al., 2009 on Mowery and Ziedonis, 2002]. Previous research shows that there are often conflicts between industry and universities over intellectual property ownership. Universities may have unrealistic expectations about the commercial potential of their research (Clarysse et al., 2007), which can result in their overvaluing intellectual property. Knowledge transfers involve the exchange of information and it creates asymmetric problems, when the industry cannot fully define the value of knowledge before the purchasing of it (Hoekman et al, 2004, 4-10).

The measurement of transaction related barriers includes the following four items: intention of the industrial liaison to oversell research, royalty payments from patents and other intellectual property rights, concerns about confidentiality; low profile of industrial liaison offices in the university.

Focus on the commercialization of research from universities undermines the public commons of science, impairing the institutions of open science through the infliction of private norms on public actions (Salter et al., 2009, 10-17). But Etzkowitz et al (2000) suggest that the rise of the university as an economic actor creates a new body of economic development, which has a positive effect in a market economy.

It was made an attempt to measure the effect of obligations with industry on the academics' behavior by studying the influence of patenting on individual researcher's publication activity [Salter et al., 2009 on Agrawal and Henderson, 2002]. These studies proposed that there are complementarities between industry collaboration and scientific performance, and that individual researchers, which create the valuable research are also successful at engaging in practical problems and making commercial value [Salter et al., 2009 on Rothaermel et al., 2007].

Evidence from the U.S. since the Bayh-Dole Act, proposes that although the rate of university patenting has risen since the early 1980s, the quality of these patents has dropped dramatically over time [Salter et al., 2009 on Mowery et al., 2001]. Cezaroni (2011) suggested that the rise in the university patenting has been accompanied by a plunge in joint research collaborations and in the pace of private knowledge operation within several technological areas. The way of knowledge creation in the private sector is dictated by the goal to appropriate the economic value in order to receive competitive advantage. This private knowledge is relatively closed, remaining hidden within the company or disclosed in a limited option through patents filed mainly for the purposes of obtaining interim monopolies.

Both scientists and industry's managers frequently claim that university bureaucracies are inflexible. They believe that universities wish to follow rigid procedures that may not fit a particular situation. Furthermore, they noted that these procedures are unwieldy and often not clearly specified (Siegel et al., 2003, 12).

3.3. Access to foreign R&D and domestic knowledge substitution

The biggest part of R&D conducted is handled by developed industrial countries, and productivity gains are widespread over the world. Following Siegel (2003), there is a postulate that knowledge spread from technology-advanced countries to technology-following countries (Bin Xu et al., 2005, 4-6).

According to Braga and Willmore (2005), domestic firms may become more aware of the technological options available to them. These firms could be resistant to the competition and find supply of foreign knowledge, which improves their position on the domestic market (Ibid, 2005). Developing countries can receive a lot of benefits from uncompensated spillovers, which can arise from imitation, foreign trade and foreign direct investments (FDI) (Hoekman et al, 2004, 4-10). FDI may provide developing countries with more efficient experimental development, and thus in greater competition.

Domestic firms can learn from the foreign products, reversing the technological innovations embodied in these goods. Effect of this substitution depends on the openness of the developing country to international trade and quality of the labor force. [Hoekman et al, 2004 on Schiff et al, 2002].

Obvious motives for transfers in the developing countries are the monetary returns in case of licensing out or R&D contracting with the local firms. Licensing of foreign patents is an important source of knowledge for developing countries (Correa, 2003, 14-19). This could help developing countries to receive production, distribution rights and the underlying technical application. Licensor firms are intended in this kind of flows, because they are confident that proprietary knowledge will not leak into different areas of the host economy. But on the other hand, leak of knowledge is inevitable, because any transferred knowledge and technology could be easily copied and technical staff can move to the competitor firm – in that way, foreign firms may prefer FDI (Hoekman et al, 2004, 8-11). Vast amount of know-how is still transferred without official payments and innovative knowledge flow away via informal contacts (Veugelers et al., 2002, 3-5).

Purchased foreign technology could become a catalyst for domestic effort: it needs to be adapted to the local conditions (Veugelers et al., 2002, 2-7) and the relationship of complementarity prevails in substitution. Gradual implementation and adoption of basic foreign research is the optimal for host firms in a way of costs and uncertain returns. Smart producers first will apply it to a small part of their capacity, and if it is valuable and

profitable, they gradually increase further application over time (Hoekman et al, 2004, 9-12).

Whether subsidiaries of the foreign firms are channels of technological spillovers and sources of knowledge transfers to the local economy, there are two conditions required to be fulfilled: foreign subsidiaries should source knowledge internationally and this knowledge should be transferrable into the local market (Veugelers et al., 2002, 5).

Developing countries lag behind the technology frontier; they rely much on inflows of the foreign R&D to improve their technological base (Pack et al., 1997, 6-10). Such inflows of the foreign technology and domestic abilities to utilize imported knowledge interact in positive ways. Developing countries are likely to have slower growth if they rely only on the domestic R&D, which could be less efficient and more costly than ones in developed countries, given their larger R&D efforts and long experience (Pack et al, 1997, 22-29). From the organizational point of view, cooperation between firms in developing countries and foreign R&D institutions can positively influence on the competitiveness of the developing countries not only on the domestic, but also on the global market (Hagedoorn et al., 2000; Takayama et al., 2002).

The majority of the world's R&D is undertaken by multinational corporations (Coe et al., 1997). According to Pack and Saggi (1997) the big corporations from industrial states as U.S., U.K, and Germany have the major influence on the technological development in developing countries. Empirical microeconomic studies show if firms in developing states start to purchase equipment, labor, and components identical to that in developed countries, not many positive changes in their productivity happen (Ibid, 22-29). In case of the knowledge' purchase, first investments are quite big, but it gives more positive outcomes in future productivity level [Pack et al., 1997 on Nelson and Pack (1996)].

Blalock and Gertler (2008) consider that firm's knowledge absorptive capacity influences the technology adoption. Firm's ability to recognize the value of the new information and correct implementation of this information in commercial strategy would

likely influence firms ability to use external knowledge from the foreign sources (Cohen et al., 1990). Cohen and Levinthal (1990) propose that a firm can build absorptive capacity by engaging in organizational activities requiring common language and familiarity with technical and scientific developments in the concrete field.

4. Co-operation between industry and R&D institutions in Russia

Effectiveness of the modern innovations could be evaluated by multiple sources of knowledge, innovative practices, and channels of sharing information. The benefits from innovations can be expressed through capabilities leading to higher added value, increase in the productivity and new business opportunities. It is very important to focus on the long-term R&D activities for the transformation of innovations into competitiveness.

The institutional instability in Russia, which was echo of the post-Soviet period, has created chaotic conditions for partnership between industries and R&D institutions and generated obstacles to firms' growth and innovation activity. As an overall result, current efficiency of the R&D complex in Russia is the lowest in the group of fast growing economies — BRIC countries: average citation of one Russian publication is 4.8 times, while of Indian — 5.8, Chinese — 6.1 and Brazilian — 6.38 [Dezhina, (2012) on Nauka, *tehnologii i innovatsii Rossii*, 2011: 79].

The Russian government realizes the role of modern R&D complex for business, and in recent years it has initiated a system of measures, aimed to encourage innovation activity in the business sector. These measures include a set of actions, which push companies to outsource R&D from the domestic universities (Dezhina, 2012, 3). The government's goals were strengthening linkages in innovation system and improvement of research in universities; pushing universities to develop research towards industry's needs, encouraging business to make longer-term horizons for their R&D proceedings.

There are not too many measurements about parameters of communication and interaction in Russian system of innovation analytics. Development of institutional cooperation and partnerships is related to social changes at the micro level. This indicates the critical importance of distinguishing behavioral effects, both at the side of industry and science.

Regarding problems of the university-industry links in Russia, it is necessary to take into account the specific character of the Russian R&D sector that has an extremely heterogeneous nature and located in a multidirectional transformation level. A lot of

decisions in Russian innovation policy system are determined by the urge to raise the contribution of the R&D to socio-economic development and to encourage the researchers into cooperation with industry. (Simachev et al, 2014, 5-12)

According to the OECD Technology and Industry Scoreboard (2013), the estimated share of firms in Russia, involved in innovation-related collaboration in the total amount of innovatively active companies in the country was at the level of 58 percent, that appeared quite high (Fig. 1, Annex 1). At the same time, the share of innovative R&D-funding firms in Russia is much lower than in the other developing countries: “the majority of innovations have imitational character, and research spending is replaced by acquiring already materialized one” (Simachev et al, 2014, 5-12). As for the direct cooperation between companies and research institutions, this indicator in Russia is significantly lower compared to other countries: cooperation has been observed only in 23 percent of big innovative companies (Figure 1, Annex 1).

Looking into index of development of science and industry partnership, Russia is placed behind leading nations in the rating of innovative economies and even behind countries, which are analogous to it by the complex level of socio-political and economic development (Ibid, 5-12).

In the statistical data from Table 1 (Annex 1), chemical industry in Russia has a highest rate of funding R&D, but only half of the chemical companies from this research sample are interacting with public research institutions. Oil and gas industries and timber industry engineering are more dynamic in outsourcing their R&D projects.

Big Russian chemical companies tend more to cooperate with research institutions (Tumin et al, 2013). They have sufficient labor and management resources to support their cooperation with R&D institutions. Analytical evidence from statistical data (Simachev et al, 2014, 8-12) explains that there is a link between the scale of a business (measured by amount of personnel) and the presence of activity to conduct R&D. The bigger the company size, the greater the number: the blue pillar illustrates the share of firms funding

research in principle, green one - the share of them who already involved in cooperation with research institutions (Figure 2, Annex 2).

The nature of the relationship in Russian companies, who are operating on market longer time, is quite specific. The features of the high cooperative activity is observed in enterprises founded over 20 years is that cooperation with science is based on traditions established in the Soviet times (Simachev et al., 2014, 9). Lack of young businesses cooperative activity and startups as the source of generating demand for R&D is the main characteristic of Russian institutional environment.

30 percent of the chemical industry are not interested in innovative research projects, thus they do not want to invest in them (Федеральное агентство по науке и инновациями Российской Федерации, 2006). Usually they are big companies, who have a monopoly on the market or they are very close to a monopoly, and they do not need any competitive advantages (Ibid, 2006). But at the same time, another tendency was discovered: around 70 percent of companies do not have a clear understanding about what is going in a concrete science area. They do not have information about which kind of R&D are available and how is possible to use these R&D for innovative production development.

Private companies are more optimistic about partnership with academics if they already have some experience of interaction (Simachev et al, 2014, 13-16). 60 percent of analyzed Russian chemical companies which R&D expenditures, underlined a good practice of cooperation while conducting joint activity and 55 percent of these organizations are oriented at such cooperation in the next 3—5 years (Федеральное агентство по науке и инновациями Российской Федерации, 2006).

Table 2 (Annex 2) presented results of the survey about evaluation of most important barriers to effective cooperation from science and chemical industry perspective. Replies divided into two groups: ones belong to chemical industries and research organizations, which already had experience, and others belong to chemical industries and research organization without interaction experience. It is obviously seen, that chemical

industry management and science representatives understand otherwise the importance of various problems on the way to successful and effective cooperation.

For business representatives interacting with science, the major drawbacks of R&D institutions are inflated costs of developments, insufficient orientation at company needs, discrepancy of developments' quality and company expectations and needs.

For researchers, the primary barriers were the lack of firms' susceptibility to innovation and incorrect information about promising developments. They emphasize the issues of fair distribution of IP rights and unclear legal regulation of joint projects. Opaque legislation and regulation are quite common problems in Russia for any type of cooperation and it comes from imperfections of the institutional environment (Zasimova et al., 2008). Diversity of forms of joint scientific projects is not driven by demand of scientific organizations to protect intellectual property rights, but there is the lack of industry's desire in the use of direct instruments for negotiation (Ibid, 2008).

Information barriers remain significant in the chemical sector: the lack of information about proposed developments and competitive research organizations, which have interesting and commercially effective projects. This potentially successful and useful cooperation remains unrealized; because industry and science ignore each other capabilities (Ibid, 2008).

Scientists named the lack of necessary diapason of services and low adaptation of the research organization's management to interaction with companies as one of the drawbacks from academia perspective. Thus, ineffective management in R&D institutions becomes very important, in the way of cooperation both among industries and research institutions.

Interestingly, the significance of information barriers for cooperation among business and research organizations differ. While interacting, business representatives pay less attention to the information problems. Representatives of research institutions who work in the interest of business note these issues much more than those who are not associated with business.

5. Empirical analysis of barriers to interaction between organic pigment plant “Pigment” and local academia

The chemical plant, Pigment, was founded in 1949 in the Tambov region of Soviet Union. They started with the production of organic pigments for print industry. Within 66 years, the plant developed into a big modern chemical holding, which is now in the TOP 100 of the Russian chemical companies by the annual volume of production.

Pigment is a open joint stock company, with shares separated between several shareholders. In 2002, Pigment together with the partner company „Technochim“ created the group of company „Krata“, and since that time they operate under common marketing and distribution strategy.

Approximately 860 employees are working at Pigment, and the company’s product portfolio consists of more than 350 kinds of high-quality and environmentally friendly chemical products: organic pigments, dyes for paint materials and semi-finished lacquers, acrylic and polyvinyl acetate dispersion, sulfamic acid and a wide range of special chemical for textiles. Among the regular customers are more than a hundred Russian and CIS firms, along with large clients in Europe and Asia: 20 percent of the total produced volume is exported to eleven countries of the world.

Pigment has a stable position on the Russian chemical market by annual turnover: it is number 2 among Russian producers of additives for gasoline, after GC “Volgzhs kij Orgsintez”; it is number 5 in the production of additive components to concrete after CJSC ”Uralprom”, GK „Superplast“, “Biotech“ and „Poliplast“; and it is number 8 among Russian producers of lacquers and organic pigments for paints. The total annual turnover in 2014 was 560 million rubles and increased by 23 percent (Table 4, Annex 1) and investments rose 6 percent compared to the previous year.

Pigment has many competitors around the world, such as BASF (Germany), Exxon (France), Solvay (Belgium), LyondellBasell Industries (U.S.) etc. These competitors have

huge production and distribution facilities in several European states, Asia, and North America.

Top management appreciates innovations, because they give the company strategic points because this gives the company an advantage over their competitors. Pigment has an internal R&D center - a laboratory with modern equipment, where 24 professionals are working with new technologies and creating new samples of products. According to the accounting balance, spending on the R&D in 2012 was 4 percent of the total budget expenditure, and they increased up to 5 percent in 2013. This is a very good indicator for the SME in Russia. The progression in the R&D spending means, that the company is relying more on innovation and has increased expectations from their own R&D department.

Pigment has a long history of cooperation with the domestic R&D institutions (Table 3.) First communication with Tambov TU started in early 70s. Within 30 years, Pigment and Tambov TU worked under the realization of the Soviet government plans, and they had access only to basic research from the University. But in 2000, Pigment and Tambov TU proceeds ran into new age of the cooperation as independent market actors. 35 R&D projects were conducted within next 6 years and the most famous ones were:

- Controlling intelligent system of Schaeffer acid production in 2000
- Steering and controlling system of the process of drying dyes, 2001
- Technology of decreasing energy consumption and increasing effectiveness of the work of valtselent dryers in 2001 (for paint production in the work sector)
- Technology of the heat exchange in nitrate reactor in 2002
- Reconstruction technology of the reactor-oxidizer in 2002
- Creation of the micro granulated bleach «КД-2» in 2003

More than 70 percent of these R&D projects were conducted with all of the financial support coming from the government; due to execution of the scientific-technology program of the Ministry of Education of Russia «Scientific research of Universities in the

priority areas of science and technology" subroutine 203 "Chemical" for period 2001-2005». Governmental projects such as these represented experimental development in which Pigment had an interest.

The decrease of the joint activities between Pigment and Tambov TU started in 2007, when the government began to reduce financing in organic chemistry R&D projects in Tambov TU. Compared with 12 years ago, «Pigment's cooperation on R&D with Tambov TU dropped almost 2 times. As the company's representatives explained, University changed orientation towards execution of the Federal Program "Research and Development in the priority areas of science and technology complex of Russia" for 2007-2012, subroutine „nano-technology“.

Despite the fact that previous cooperation did not involve transaction-cost side, Pigment was faced with the University's bureaucracy and tough administration procedures. Among other issues were the information exchange problems and difficulties with perception of complicated scientific work. In 2014, the company increased the budget for the R&D, but none of these funds were extended to projects with Tambov TU.

Pigment decided not to invest in R&D projects with Tambov TU, because they did not want to buy overvalued IP. Pigment found that foreign technology transfers and the quality of foreign R&D matches to be better suited to the company's expectations and more attractive in the ways of price vs. quality.

Even if a company purchases basic research from abroad, this research will still have to be adopted and implemented to local production and it requires communication with the domestic R&D institutions. Thus, the co-operation between Pigment and domestic R&D institutions – Tambov TU, seems to exist.

Capabilities and knowledge base

External and internal knowledge are the main sources of innovation for Pigment. Pigment's external source knowledge is basic research from scientific publications and other R&D institutions' scientific proceedings, experimental development from purchased

patent's descriptions, and technology transfers from FDI. Basic research is used for increasing internal capabilities, which later appears in experimental findings and laboratory research of their own R&D center. The knowledge base in Pigment R&D center grows over time; together with the trends and the demands of the chemical industry and specific technology. But experimental knowledge and technology transfers are still the most important sources of increasing technological competences in the company. Human capital is another internal capability of the organization, and within next three years, Pigment's plan is to expand their own R&D center and hire more engineers and scientists. Now, the company has a lack of professional technologists and engineers, who know the features and specifics of the chemical industry, and understand the trends on the chemical market. The representatives from Pigment added that the good specialist is a researcher and professional, who know how to implement efficiently knowledge gained in product development.

Knowledge transfer practice and issues

Pigment's decision on the cooperation with R&D institutions is based on the motives of increasing welfare and competitiveness on the global market. Cooperating with the University on governmental projects, helps the company minimize their own R&D costs and increase internal capabilities. A decision about choosing partners on the R&D cooperation is based on the amount of costs for conducting R&D, and the evaluation of risks with uncertainty of results.

The company receives experimental developments via licensing of foreign patents and FDI from Czech Republic, Austria, and Sweden. In 2012 Pigment signed contracts with specialists from AkzoNobel Sweden and BASF Austria about engineering the new production facilities and implementation of experimental development. The company is always seeking new ways of knowledge inflows and thus is interested in new R&D partners. Since 2002 Pigment does not have any long-term contracts with R&D partners: it acts as intermittent partner in co-operation with several Russian Universities (including

Tambov TU), but it behaves more as recurrent partner with foreign R&D institutions. Representatives from Pigment underlined that personal interactions with scientists and engineers are very important for successful implementations of applied research, and they were seeking this in previous cooperation with Tambov TU: scientists were not good in communications, mostly keep in contact by mail. Their teamwork was not organized well, because several team members came back to Pigment representatives with the same questions and issues. Opposite to the domestic R&D institutions, foreign R&D partners prefer to establish personal relations and come to see production facilities and capabilities.

Conflicts of incentives

Tambov TU has a priority for the execution of governmental scientific programs, also because it is a public institution and depends on the government funds. Thus private business projects are usually in second place for them. The University's management does not follow marketing trends in the industry, thus they do not understand which kind of practical research could be commercially valuable for industry. Tambov TU has great orientation on the development of basic research, but they do not have a good capabilities and competences for the development of experimental research. The administration procedures in the University require different applications and confirmations and sometimes it takes long time to start any project. After spending a long time under rules of command regime, now the University has difficulties with adoption to the market economy and could not behave as appropriate market actors.

IPR issues and transaction-related barriers

In 2009 the Russian Government passed the law №217-ФЗ about creation of technology transfer enterprises (TTE) in Universities and governmental R&D institutions. One such TTE was opened in Tambov TU in 2010. This center handles issues with the registration and maintenance of the IP objects, promotes the practical application of results of IP, evaluates the IP and provides legal support related to licensing. On the one hand,

TTE makes the procedure of R&D outsourcing and patents' licensing easy, but on the other hand, such a center concentrates the power to establish unnegotiable price and blocks direct communications with scientist about the evaluation of their research. There is no clear understanding how the University evaluates the cost of IP, and this gives them the opportunity to set unrealistically high prices in order to earn more money. Opposite to the foreign R&D partners, domestic Universities work only with prepayment conditions, which make more constraints with accounting. But transactions between Russian companies and foreign ones are more complicated due to Russian legislation: Pigment should pay import fees for purchased research or licensing a patent. "Russian legislation is made to prevent money outflows from the country, thus we prefer to keep limits on the foreign transaction in order to avoid big import taxes and the repeated financial audits", - explained the respondent 2.

Foreign substitutions

Pigment actively uses foreign R&D for increasing their internal knowledge base. Foreign research looks very attractive from the point of commercialization, and allows producing chemicals, which are demanded not only in Russia, but also on the global market. Foreign R&D sources give Pigment incentives to develop their own knowledge base and adopt basic research to current production facilities, without additional expenditures for equipment and materials. According to the opinion of the representatives, purchasing foreign knowledge is more effective in a way costs vs. values in a long-term perspective, than purchasing equipment, materials and specialist from abroad.

When purchasing R&D from abroad, Pigment is faced with the challenge of effective implementation of this research into current production. The company has support in adaptation of R&D from BASF and AkzoNobel, because they are directly investing in Pigment production. But, when Pigment outsources R&D to foreign institutions, the company must pay for extra supplementary services, such as revision R&D into current production. In this case Pigment either will hire foreign specialists on a temporary basis, or

try to use technological capabilities of own R&D center to refine purchased technology and apply it on the production.

FDI provides Pigment with great competitiveness and better results in technological spillovers, and now it is the optimal way of technology transfers for the company. However, foreign countries are afraid to invest in Russia due to instability of the national currency, unpredictable trade policies and imposition of sanctions for international trade.

Even though the Russian government introduced recently several directives on outsourcing R&D from domestic universities, Pigment representatives believe that their scientific competences are relatively low. Unfortunately, domestic universities have limited absorptive capacity and they could not refine foreign R&D projects without the support of the foreign experts. Therefore, Pigment prefers to skip domestic universities and directly establish cooperation with foreign specialists about R&D revision. Foreign specialists are more practical oriented and know the specifics of certain chemical production better than scientists from the local university.

The company's intention is to grow good professionals in their own R&D center, thus Pigment actively accepts interns and graduates from universities for internship. The company's management has a great plan to make in-house R&D center as a small alternative to the local public R&D institutions.

After analysis of interviews with industry representatives, questions for interviews with scientists from Tambov TU were prepared.

The scientist 1 explained that the universities appreciate the cooperation of business in innovative research, but unfortunately business is targeted only in valuable commercial projects; but the universities are mostly interested in fundamental research, which is related to current priority directions of science research policies of the Russian Government. The scientist 2 said that any project on the development level is required permanent involvement of the industry and additional financial support, however business wants ready commercial solutions easy embedded into current technology process. Both scientists that were interviewed marked that industry does not want to be involved in preparation of the

new R&D projects and especially pay in advance for it. Unlike from the industry, nowadays Government is the only big investor in scientific work and experiments. “We are interested in valuable practical projects, which could help Russian companies to be demanded on the domestic and international market, but we could not start a new project without support, include financial investments” – concluded both scientists.

6. Discussion

Empirical studies and conducted interviews with representatives of Pigment showed that institutional cooperation is an important source of input for industrial innovation process inside the company (Schartinger et al, 2002, 1-3) and cooperation helped Pigment to improve the internal scientific competences. It was founded that domestic universities are the good source of human capital in the way of the education of graduates and personnel trainings for industry researchers, but in contradiction to Schartinger (2004) the basic research from Tambov TU was not directly applicable to Pigment's production.

It is proved that Pigment belongs to science-based industries, because it strongly relies on the experimental research from its own R&D center and seeks out opportunities to include modernizations from external R&D sources (Pavitt, 1984). Long history of diversified specialized productions and institutional cooperation were background for accumulation of specific knowledge, and this is opposite to Nelson (1982) that "entrepreneurial" approach of knowledge creation is prevail in the science-based sectors.

Chemical engineering becomes more and more popular among science-based industries. (Cimoli, 2006, 6-15) Pigment also creates possibilities for development of chemical engineering in own R&D center. The company actively attracts scientists who know the practical side of chemical production for joint work with engineers in the in-house R&D center.

The company's decision about cooperation with R&D institutions based on the motives of increasing internal R&D capacity through the external sources of knowledge and minimization transaction and production costs. Thus it is true that Pigment is moved by transaction-cost and resource-based approaches, (Arranz et al., 2008; Kogut, 1988) when cooperating with R&D institutions.

Basic research from the domestic Universities is not a very important way of knowledge transfer for Pigment, but experimental development and technology transfers are more necessary because they bring practical and commercial value. Thus, the company

acts as an intermittent partner with domestic R&D institutions. Disproving statement of Gomes (2005), Pigment does not obey easily the necessary routines of the R&D institution and usually intend to defend the own point of view about the research targets. Opposite to Scharinger (2002), Pigment representatives confirmed that personal interactions are stronger in technology transfers related to FDI and licensing of the foreign patents, than in the knowledge flows from the local universities. Nonetheless, they agreed the quality and mechanism of cooperation depends on the informal interactions and the level of personal trust (Ibid, 2).

Pigment representatives underlined the difference in orientation of R&D institutions towards their goals (Rynes et al., 2001, 2-3) and difficulties with perception of complicated scientific language as the main obstacles to the cooperation: this is the evidence from Siegel (2003) that universities are driven by an internal dynamic, and not considering much the marketing value and commercial side in their research.

It was not approved by empirical studies that industry seeks alliances with academia mostly because of the disability to solve scientific issues by themselves (Rynes et al., 2001,8-15) – firstly, Pigment seeks cooperation in order to develop internal capabilities for creation of innovative technology, and secondary, it comes to R&D institutions with issues, which they cannot solve by themselves.

Empirical studies approved that appearance of the Technology Transfer Enterprise (TTE) in the Tambov TU increased the commercial focus of the university on the evaluation of IP: they got the freedom to explore IP for financial gain and establish unrealistic prices (Clarysse et al., 2007). Therefore following the ideas of Cezaroni (2011), the decrease in joint activities between Pigment and Tambov TU was expected. The ideas of Hoekman (2004) about impossibilities to define the value of R&D before purchasing were confirmed within interviews with the company's representatives. In empirical studies it was discovered that transaction-related barriers could happen due to limits and restrictions on the money outflows from Russia to abroad. This subject was not covered in

the theory and requires more detailed analysis of Russian legislation and tax system on foreign transactions.

Pigment actively uses foreign sources of knowledge, and heavily relies on them: according to Braga et al (2005) it improves the company's competitiveness on the domestic and international market. The ideas of Veugelers et al., (2002) about foreign technology transfers are catalyst for domestic efforts was not confirmed in empirical studies: Pigment representatives claimed that it does not affect the domestic university's efforts to improve scientific competence, but it forces the company to improve internal R&D capabilities engaging in organizational activities, required familiarity with technical issues and common language with foreign specialists for implementation of purchased knowledge (Cohen et al, 1990).

FDIs are one of the most effective sources of technology transfers for Pigment. In developing economies, which Russia is included, and the statement of Hoekman et al (2004) about benefits from FDI spillovers for developing countries is confirmed. Pigment receives great results in technological spillovers (Table 4 in Annex 3) and becomes more resistant to competition on the domestic market. Even FDIs are good for sender and host economies (Hoekman et al, 2004, 8-1), such industrialized European countries prefer not to invest much in Russian companies. This problem was mentioned in interviews with Pigment representatives and it requires deeper analysis of Russian institutional and political environment.

The company's representatives mentioned that foreign chemical enterprises, as BASF (Germany), and AkzoNobel (Austria), Exxon (France), Solvay (Belgium), LyondellBasell Industries (U.S.) are not only the big competitors, but also the huge scientific incubators. Thus Pigment following technological trends, hire specialists from these companies and organize trainings with foreign specialists for the staff in their own R&D center. Multi-Nationals Enterprises (MNE) have a great capacity for undertaking R&D and accumulate the biggest part of the world innovations, and it was proved by theory

of Pack and Coe (1997) about the influence of MNE on the technological development in less-industrialized countries.

This research investigated the barriers in recent years, but there is a need for future research to explore interactions over time, and examine the factors that lower or raise the barriers to collaboration. It could be new policies related to the university IP and changes in the university funding regimes. For most of the Russian firms, cooperation with domestic universities is a long process of learning from informal and infrequent interactions to long-term sustained partnerships, and there have not been sufficient studies, which investigate the progression of this process.

The qualitative analysis suggests that universities need to improve understanding of the industry's needs. There is also considerable room for enhancing the effectiveness of the commercial side of the university–industry interactions. Earlier policies of the Russian government had a tendency to encourage the university—industry cooperation and the government created a lot of new scientific programs. But, it did not increase the scientific competences of the domestic universities. Therefore, future studies should be focus on the formation of the scientific competence in the Russian universities. Detailed research and knowledge creation in the Russian NSI over time could give broader ideas about the role of the institutions and innovative actors in Russia. Such proceedings may offer the greatest potential for effective future policy implementation to support the domestic universities and industry collaboration.

7. Conclusion and recommendations

Private companies find institutional cooperation beneficial in a way of access to advanced scientific findings, which could improve their technological competences and internal innovative capacity. Cooperation with R&D institutions could be helpful for companies in resolving difficulties with obtaining basic research into production and they could get more opportunities to improve their position in the global market.

There are different types of knowledge transfers, and according to theory of Pavitt (1984) industries, belonging to different sector patterns rely more or less on the different types of knowledge transfers. Organic pigment chemistry, belonging to science-based sector (Gilsing et al, 2011) relies on the basic research, which is available via publications, research proceedings, reports and patent descriptions. But, in empirical studies, it was discovered that experimental development and technology transfers play a crucial role for chemical industries too. Preconditions for successful knowledge transfers are based on personal trust: close and face-to-face contacts, overlapping personal and professional relationships, and allow establishing long-term partnership.

Operating by different incentive systems, universities and industry face problems within cooperation: academics and practitioners have fundamentally different frames of perception of information (Shrivastava et al, 1984) and they have notable differences with respect to the each other goals and motives (Rynes et al., 2001,2-3). The main revealed problem for scientist is companies' low receptivity to basic research. Scientific approach is based on the broadening scientific horizons and on the value of learning effect. While entrepreneurial approach assumes the importance of practical value of the research and the priority of commercial benefit of a project. Entrepreneurs are interested in performing external research as soon as possible and in the presence of visible commercialized results.

Transaction-related barriers and conflicts on the evaluation of IP have become more prevalent in the university-industry cooperation. As a consequence of designed policies, the universities are encouraged to create TTE in order to increase the commercialization of

research and to adopt aggressive strategy towards negotiations over IP rights (Siegel et al., 2003).

Developing countries rely largely on imported technologies as sources of new productive knowledge (Pack et al, 1997). Inflows of foreign R&D together with domestic abilities to utilize imported knowledge influence in positive way on the economy of developing countries. Cooperation between firms in developing countries and foreign R&D institutions on the commercial technological projects can positively influence on the competitiveness of the developing countries on the domestic and global market (Hagedoorn et al., 2000, 7-18)

FDI and licensing of foreign patents are the most common ways of receiving positive technological spillovers for developing countries. However, successful implementation of foreign R&D requires local firms to learn how to adopt the applied research to the current production facilities (Veugelers et al., 2002, 2-7).

Cooperation between chemical companies and universities in Russia is still placed on the primitive level: it is based on the traditions of Soviet period with presence of organizational bureaucracy and small respects to the interests of each other. (Dezhina, 2012, 3) Universities, being an important input for the innovation process and knowledge creation (Serrano-Bedia et al., 2009, 8-10), occupy a modest place in the Russian R&D system: there are a lot of universities in Russia, but their R&D capabilities are very low. Russian universities are almost not present in international rankings of the top universities, mainly because of a relatively weak research performance and absence of international staff.

The biggest source of findings for R&D conducting in the local universities is the Russian Government. Business provides little in the way of financing for R&D, however they would like to gain more benefits from governmental R&D, which would help them increase their own in-house R&D capabilities. This style of cooperation is characterized by lack of startups as the source of demand for R&D.

The share of innovative R&D-funding in companies in Russia is very low, compared to the industrialized countries, and the majority of innovations have imitational character and research expenditures are replaced by acquiring already existed foreign patents. This resource-based view and transaction-cost approach on cooperation are typical for Russian science-based sectors, which chemical industry belongs.

Partnerships between chemical companies and universities in Russia have an acquired intermittent character. From the point of business, insufficient research organizations' orientation on company needs, inflated costs of IP, and low quality of domestic research is the main obstacles for cooperation. The industry's representatives complained that university researchers are complicated and "too philosophic" in their studies, thus it makes it hard to perceive research information. University researchers are not much social and prefer interactive ways of communications to personal face-to-face contacts. Therefore industry marked information exchange as one of the important barrier within cooperation.

According to the interviews with university researchers, the obvious reason of academia's low interest is a lack of financial and practical support from the industry. The industry's desire is to receive commercially valuable project in a short term, with small investments and less involvement.

Foreign R&D gives opportunities for Russian companies to penetrate on the global market and increase competitiveness. Imported experimental research and technology looks more attractive from the point of commercialization. It is more attractive in a way of costs vs. values in a long-term perspective.

Russian universities are not interested in refining foreign knowledge, thus industry increases absorptive capacity and internal scientific competence in order to adopt foreign knowledge into current production facilities. Absorption of foreign technology and its translation into competition depend on the quality of human sources and supply of

engineering. Thus Russian companies are in cooperation with domestic Universities about acceptance of graduates and young scientists for practice in the internal R&D centers.

The Russian government tried to reduce the distance between local universities and private companies and issued policies to encourage cooperation. But the problems of low scientific competence and lack of human capital within the domestic universities turn the industry choice towards foreign sources of knowledge. Based on the theoretical material and empirical findings, the hypothesis that modern Russian chemical companies prefer to substitute domestic sources of knowledge with foreign ones was affirmed. Empirical evidence confirmed the importance of incoming spillovers and the performance of in-house R&D activities as the determinants of institutional cooperation. Industry prefers to develop internal R&D capabilities by hiring scientists from foreign MNE in order to receive efficient sources of basic and experimental research.

On the basis of the conducted research, there are could be identified several recommendations for the improvement of the university-industry cooperation:

- Strengthening of university intention towards solving practical issues and tasks in the interests of business. It means that business should provide universities with practical challenging tasks and then actively participate in the preparation of research.
- Formalization of relationships among companies and universities. It requires transition from contacts at the level of researchers and professors to the joint focus-groups and laboratory practicums.
- Establishment of start-ups on the basis of universities.
- Integration of research and education. Successful cooperation resulted in development of human capital. Universities and industry should both become stakeholders within the educational system, and take an active interest in the education of graduate in order to grow practical orientated researchers and specialists.

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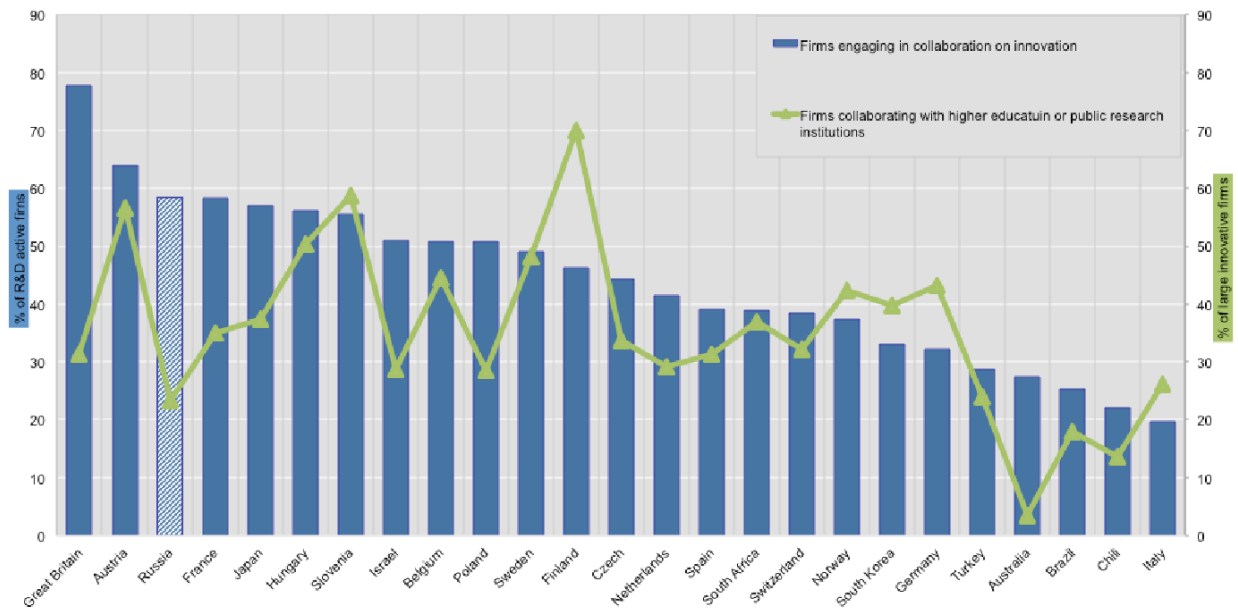
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Annex 1.

Figure 1: Proportion of enterprises interacting with other innovation actors (blue) vs. (green) interacting with universities and research organizations in the total of enterprises of each category



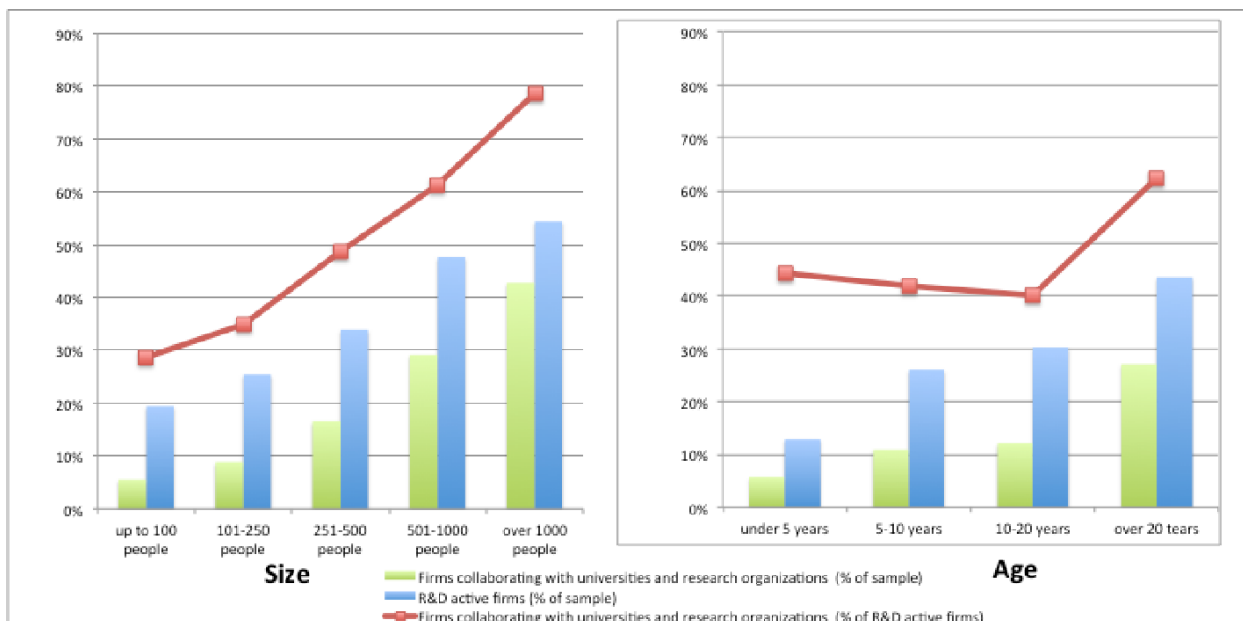
Annex 1

Table 1 Russian industries, funding in R&D and interacting with R&D institutions in 2012-2013

	Companies funding R&D	Incl. companies interacting with research sector in their R&D
Chemical production	55%	28%
Production of electrical machines and systems	50%	25%
Production of transport vehicles	48%	26%
Production of machines and equipment	46%	23%
Nonferrous metallurgy	44%	35%
Ferrous metallurgy	42%	27%
Oil and gas production	39%	36%
Manufacture of rubber and plastic products	34%	23%
Production of construction materials	27%	16%
Pulp and paper production	26%	3%
Textile manufacture	24%	11%
Apparel industry	19%	6%
Wood processing	18%	8%
Food processing, including beverages	17%	6%
<i>Total percentage in the sample</i>	34%	18%
<i>Percentage in the innovative subsample</i>	49%	29%

Annex 2.

Figure 2: Demand of chemical companies for R&D cooperation: factors of size vs. age



Annex 2.

Table 2 Significance of barriers to cooperation for industrial companies vs. R&D institutions

	Chemical enterprises		R&D organizations	
	Without cooperation experience	With cooperation experience	Without cooperation experience	With cooperation experience
No obstacles	24%	28%	10%	7%
Lack of information on national perspective developments	27%	18%	18%	29%
Research organisation poorly oriented at customer needs	29%	23%	21%	14%
Inflated national R&D costs	24%	25%	23%	11%
Disagreement between the quality of domestic developments and enterprises needs	26%	22%	17%	13%
Lack of information about competitive domestic research organisations	18%	14%	14%	22%
Domestic research organisations do not provide the necessary range of services	19%	13%	10%	21%
Cheaper and more quality foreign analogs	8%	10%	22%	18%
Ineffective management by research organisations	8%	16%		
Negative experience of relations with domestic research organisations	7%	7%		
Lack of company receptivity to innovation			19%	37%
Companies directly interact with specialists			17%	19%
The system of management public research organisations is not adapted to interact with companies			12%	19%
Business's distorted view of R&D quality due to mass media bias			9%	15%
Number of organizations	101	121	165	175

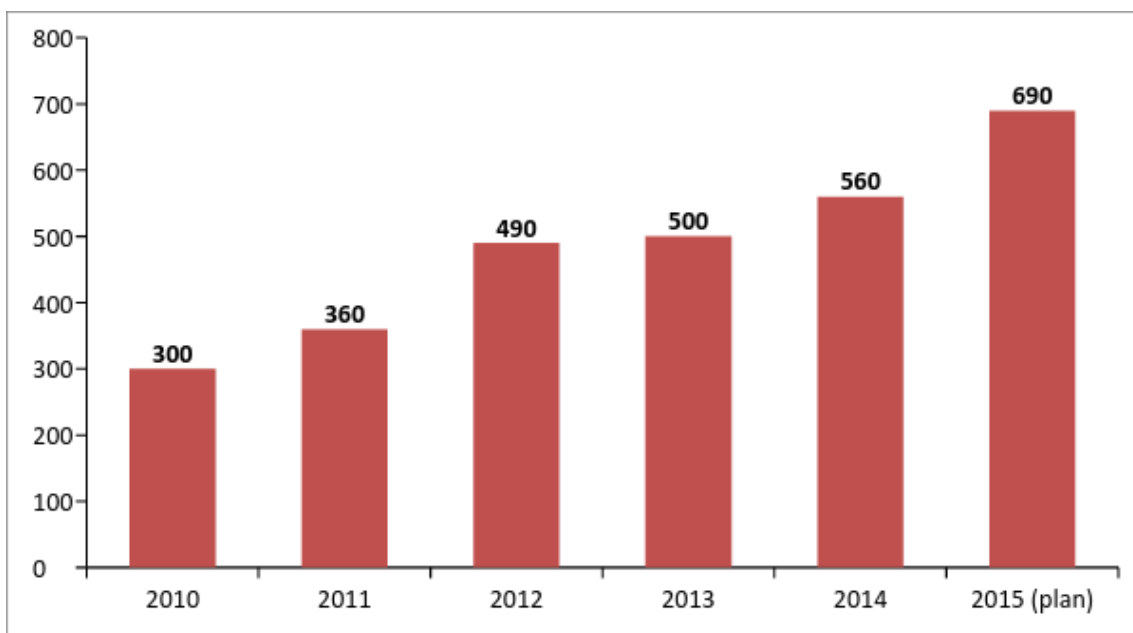
Annex 2.

Table 3 Evolution of “Pigment” production with R&D partners over time

Year	Appeared technology	R&D Partner
1949	organic pigments: 30 items	Bauman Moscow State Technical University
60-s	disperse dyes	Moscow State University, Bauman Moscow State Technical University
70-s	acrylic-containing products	Bauman Moscow State Technical University, Voronezh state Technical University, Central Research Institute of Paper in Moscow, Harkov State Technical University Tambov State Technical University
80-s	optical brightening agents and disperse dyes	Russian State University of oil and gas, Central Research Institute of Paper in Moscow, Harkov State Technical University, Tambov State Technical University
1993	gasoline additives	Tambov State Technical University
1994-1996	phenol-formaldehyde and urea- formaldehyde resin	Research Institute of plastics, Moscow
1997	paint and varnish products, the dispersion of PVC	LLC "Himtehnzhenering", Rostov-on-Don
2005	additives for concrete and acid polymer production	Tambov State Technical University
2011	production of formaldehyde resins	Sun Chemical, (Belgium), Arkema (France)

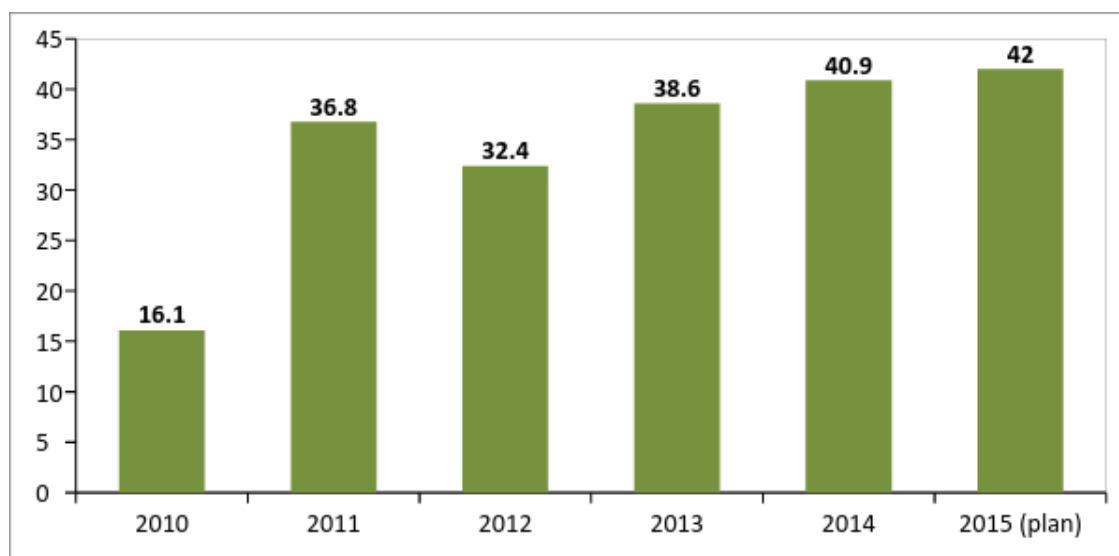
Annex 2.

Table 4 Dynamics of annual turnover (million, rub)



Annex 2.

Table 5 Dynamics of investments (million, rub)



Annex 3.

Questions for the representatives of the chemical plant „Pigment“

1. What are the main sources of innovation in the company?
2. How did innovation sources change over time?
3. Which kind of knowledge is important for the company?
4. Where do you get this knowledge from?
5. Which incentives are you driving to co-operate with R&D institutions?
6. Do you think that Universities evaluate correctly its IP?
7. Why foreign suppliers are better in knowledge transfers than domestic ones?
8. Does foreign R&D increase company's internal capabilities?
9. What is the difference in cooperation with domestic R&D institutions and foreign ones?
10. Does domestic R&D institutions are able to help with adoption of foreign technology to current production capacity?

Representatives from „Pigment“:

The representative 1: Senior engineer organic pigment production, Alexander Ionkin

The representative 2: R&D project manager, Artjom Birykov

Questions for scientists from the chemical department of the Tambov TU.

1. Is it true that the local Universities are less orientated on business needs and more orientated on the development of the Government's projects?
2. What are the reasons for low orientation towards private business' projects?
3. Does the local R&D institutions have enough capacity to process foreign technology and refine it for domestic production?

Researches from Tambov TU:

The scientist 1: PhD Chemical Department, Olga Isaeva

The scientist 2: PhD Chemical Department, Irina Zaitseva